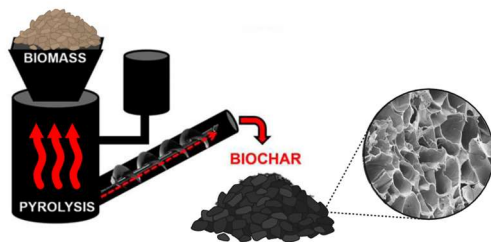


## What is biochar?

- Biochar is a special form of charcoal that has been produced since ancient times.
- Heating plant or animal waste in a low-oxygen environment allows us to create a stable form of carbon that has many useful properties.
- This heating, known as **pyrolysis**, is done in low oxygen conditions, so combustion (and therefore greenhouse gas emissions) is minimized.
- Biochar is a way to sustainably create a valuable product from waste materials!



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### Biochar resources:

<https://biochar-us.org/>  
<https://biochar-international.org/>  
<https://extension.psu.edu/biochar-properties-and-potential/>

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Special thanks to Metzler Biochar (Reedsville, PA).

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### Credits:

Biorender.com  
<https://www.frontiersin.org/journals/environmental-science/articles/10.3389/fenvs.2023.1253144/full>  
[https://en.wikipedia.org/wiki/Biochar#/media/File:Biochar\\_ready\\_for\\_application.jpg](https://en.wikipedia.org/wiki/Biochar#/media/File:Biochar_ready_for_application.jpg)  
<https://biochar-international.org/>  
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## BIOCHAR FOR SOIL HEALTH

Soil Research Cluster Lab (SRCL), Penn State University

## How can biochar be used to improve soil?

Biochar has become popular in soil science due to its unique properties:

### Highly stable carbon storage

- Biochar is not easily consumed by microbes in the soil. This means that carbon can remain in the soil for many years—reducing greenhouse gas emissions and providing a stable, slow release of carbon and nutrients to the soil.

### Highly porous structure

- The physical structure of biochar allows it to act as a sponge in the soil, holding onto water and nutrients.

### High pH

- The alkaline pH of most biochar gives it potential as a liming agent.

### Reactivity towards soil contaminants

- Biochar is known for taking up hazardous chemicals such as heavy metals and organic pollutants. Much research is being done to see how permanent this adsorption mechanism is.

## Biochar research at SRCL

### Lead (Pb) Remediation in urban soils

Research at SRCL is exploring how to enhance biochar's effectiveness in reducing lead contamination in urban soils through:

- Biochar surface modifications to improve lead binding.
- Exploring biochar potential in reduction of bioaccessible lead.
- Biochar-compost application and role of dissolved organic matter.
- Studying soil condition effects, including moisture and sulfate levels, on lead uptake.

### Greenhouse Gas Emissions

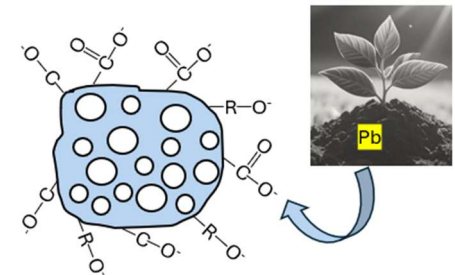
This project is evaluating wood- and poultry wastes-based biochars for their ability to lower  $N_2O$  and  $CH_4$  emissions after manure application while maintaining corn yield, helping farmers choose optimal biochar types and rates.



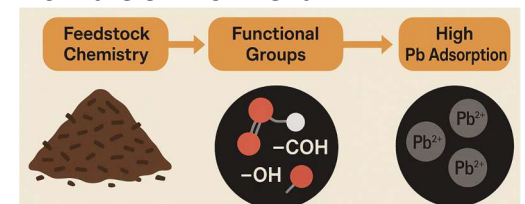
Biochar application to the corn field.

## Biochar reactivity towards contaminant metals

**Surface Functional Groups of biochar** — Carboxyl ( $-COOH$ ), Hydroxyl ( $-OH$ ), and Phenolic ( $-C_6H_5OH$ ) — control how biochar binds contaminants, nutrients, and water, enabling it to adsorb and retain metal ions.



The chemistry of the biochar *feedstock* determines the types and abundance of surface functional groups, which in turn control its ability to take up lead ( $Pb^{2+}$ ) from the environment



### Optimizing Biochar for Pb Adsorption:

Users should choose feedstocks rich in functional groups, such as wood-based biochar, which contains more oxygen groups for  $Pb^{2+}$  binding. Lower pyrolysis temperatures ( $<500\text{ }^\circ\text{C}$ ) help preserve these groups, and chemical, heat or steam activation boosts surface area and reactivity.